Space Weather Technical Forecast

Issued on Wednesday 12 March 2025 at 13:05 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of isolated M-class flares. Chance G1 Day 1. G1 likely Days 2 & 3, chance G2. Active fluence expected Days 1 & 2.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with an isolated M1.1 flare observed at 11/1304 UTC from AR2024 in the northwest. There are currently eleven regions on the Earth-facing disc. The main region of interest continues to be AR4019 in the northeast, which has seen continued development in the trailer and intermediate regions, with a weak delta spot in the compact central portion. AR4024 is small and continues to weaken and simplify, however it was responsible for a good portion of the flare activity in the past 24 hours. Recently numbered regions AR2025 and AR2026, both in the east, have shown some growth. The remaining spots have shown little change and are generally stable at present.

No Earth-directed CMEs have been observed.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE at L1, showed a declining connection to the fast wind of CH21/- at first, rising slightly again later in the period. Wind speeds were initially strong near 500km/s, declining to slow-ambient levels near 390km/s. Since 12/0500 UTC wind speeds have risen to be slightly elevated once again, currently around 440 km/s. Density was below average. Interplanetary Magnetic Field, Bt, started weak at 6 nT or below, gradually rising to moderate 12 nT. The north-south component, Bz, was weakly variable initially, becoming predominantly moderately negative from 11/2130 UTC. Phi angle was negative (towards the Sun). Geomagnetic activity was Quiet to Active (Kp1-4).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES18 was near background levels. High energy electron flux (greater than 2 MeV) reached high levels at the diurnal max, recording a max of 4110 pfu at 10/1535 UTC. The 24-hour fluence was above the Active threshold (1e8 integrated pfu) from 11/1200 UTC, now on a flat trend, with 1.58e8 integrated pfu observed at 12/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is most likely, with a chance of isolated M-class flares.

Solar Wind / Geomagnetic Activity: No CMEs feature in the forecast. Ongoing fast winds from CH21/- continue on a slow, if erratic, decline. The next coronal hole fast wind enhancement, from

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CH22/-, is most likely to occur during Day 2 (13 Mar), perhaps reaching 600+ km/s again. This fast wind should then ease later Day 3 into Day 4.

Geomagnetic activity is expected to be mainly Unsettled through Day 1 (12 Mar) , with a chance of Active to G1/Minor Storm intervals. On Days 2 and 3 (13-14 Mar) a spell of Active to G1/Minor Storms are considered likely, with a chance of isolated G2/Moderate Storm intervals. Geomagnetic activity should then reduce through Day 4 (15 Mar) perhaps falling back to Quiet to Unsettled by the end of the day.

Energetic Particles / Solar Radiation: High energy proton flux is most likely to remain close to background levels. High energy electron flux is expected to reach high levels at the diurnal peaks on at least Day 1 (12 Mar), perhaps dropping from Day 2 or 3 (13-14 Mar). The associated 24 hour fluence is expected to stay above Active on Days 1-2, potentially declining Days 3-4.

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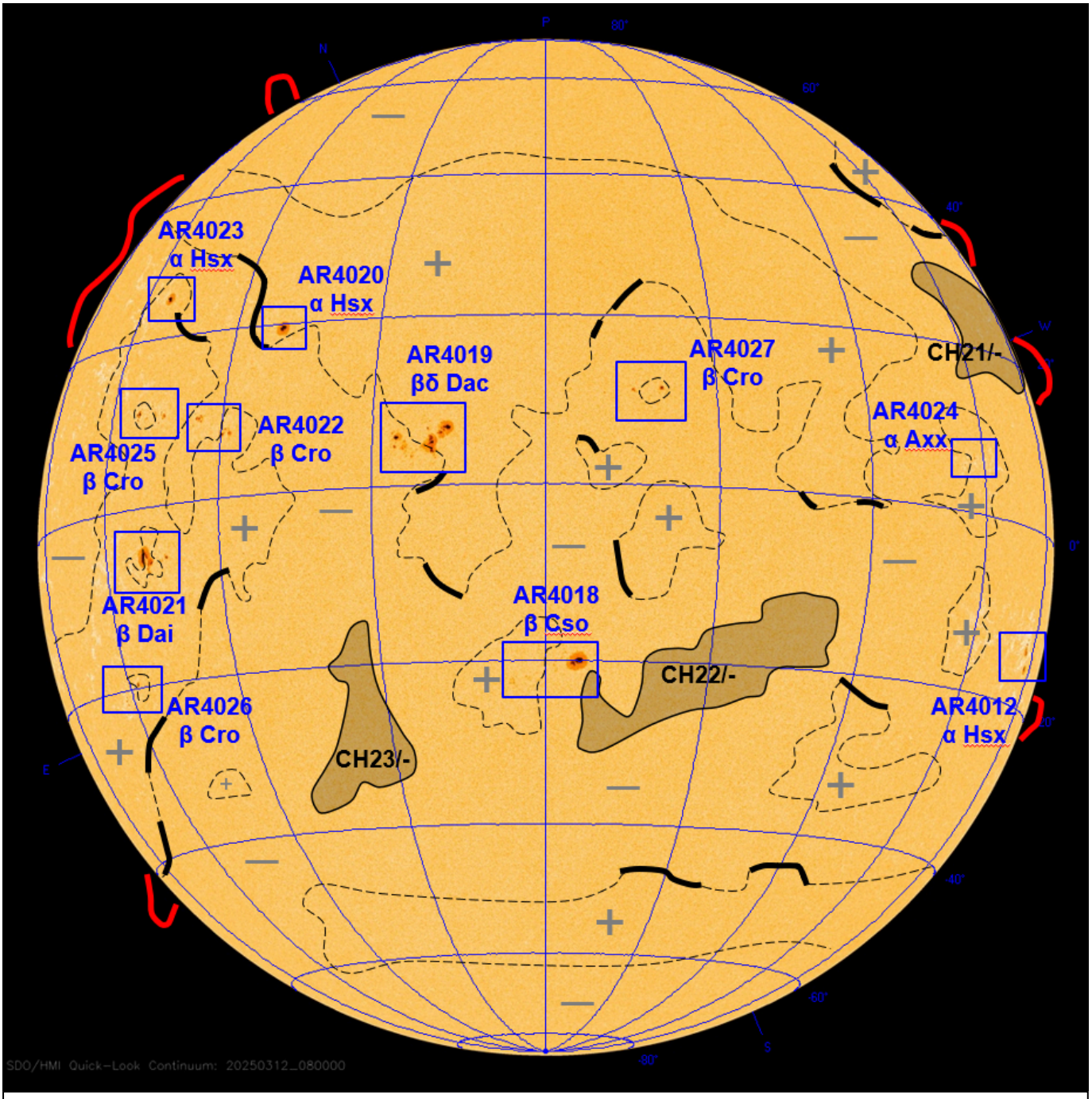
Figure 1: Solar Synoptic Map valid 12/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

No CMEs feature in the forecast.

Solar winds have shown a slow, if erratic, decline following the recent connection to CH21/-, currently at slightly elevated levels. The next coronal hole fast wind enhancement, from CH22/-, is most likely to occur Day 2 (13 Mar). This may however occur earlier on Day 1 (12 Mar), as suggested by MOSWOC Enlil, which is possible considering the recent slight rise in solar wind parameters. A possible explanation for this recent rise may be due to the fact that on the previous rotation both CH21 and CH22 had a narrow link between them. This is not visible now in imagery, but may only be obscured. That said, the leading edge of CH22 does appear to be in a similar location to the main part of the CH on the previous rotation, and a similar onset of elevated to strong wind speeds is likely, perhaps reaching 600+ km/s again. Additionally, this is a negative polarity coronal hole, which is favoured for connection to Earth at this time of year. This fast wind should then ease later Day 3 into Day 4 (13-14 Mar), with the following coronal hole (CH23/-) due beyond the end of this period.

Geomagnetic activity is expected to be mainly Unsettled through Day 1 (12 Mar) , with a chance of Active to G1/Minor storm intervals. On Days 2 and 3 (13-14 Mar) a spell of Active to G1/Minor Storms are considered likely, with a chance of isolated G2/Moderate storm intervals. Geomagnetic activity should then reduce through Day 4 (15 Mar) perhaps falling back to Quiet to Unsettled by the end of the day.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	45	80	60	20
Strong	**G3**	No	1	5	5	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

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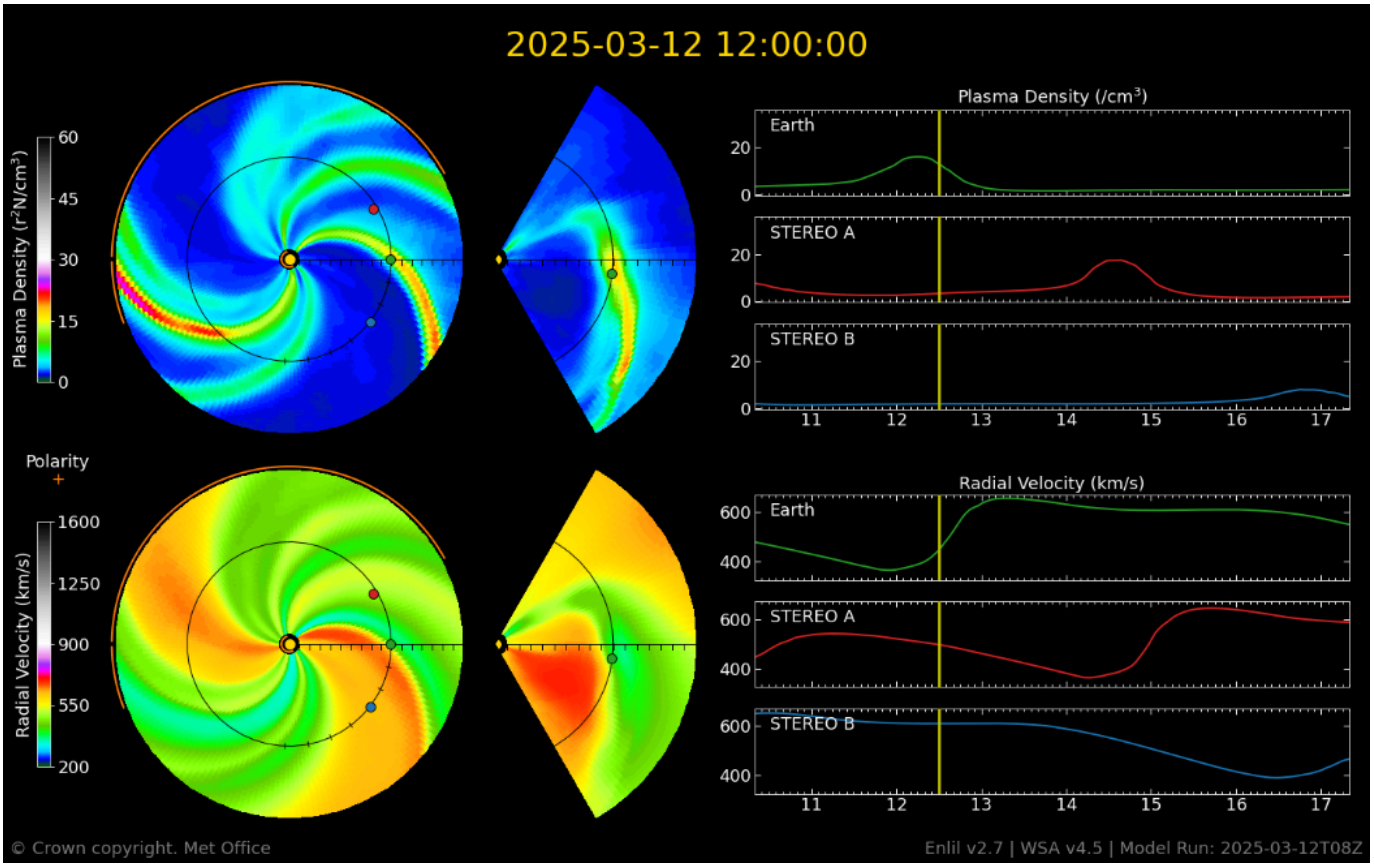
Figure 2: MOSWOC Enlil model.



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Radio Blackouts - X-Ray Flares

Solar activity has been Moderate, with an isolated M1.1 flare observed at 11/1304 UTC from AR2024 in the northwest.

There are currently eleven regions on the Earth-facing disc. The main region of interest continues to be AR4019 in the northeast, which has seen continued development in the trailer and intermediate regions, with a weak delta spot in the compact central portion. AR4024 is small and continues to weaken and simplify, however it was responsible for most of the flare activity in the past 24 hours. Recently numbered regions AR2025 and AR2026, both in the east, have shown some growth, along with newly developed AR2027 in the north centre disc, albeit all are relatively simple at this point. The remaining spots have shown little change and are generally stable at present.

There are several ex-sunspot regions which may return over the east limb during this period, with some looping showing in SDO imagery to support this. However, the potential activity levels of any new regions cannot be assessed until they appear on the visible disc. Low to Moderate activity is most likely, with a slightly increasing chance of isolated M-class flares, with perhaps the most likely flare source now looking to be from over the SE limb.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	40	40	50	50
Very Active	R3-R5 (X Class)	No	5	5	5	5

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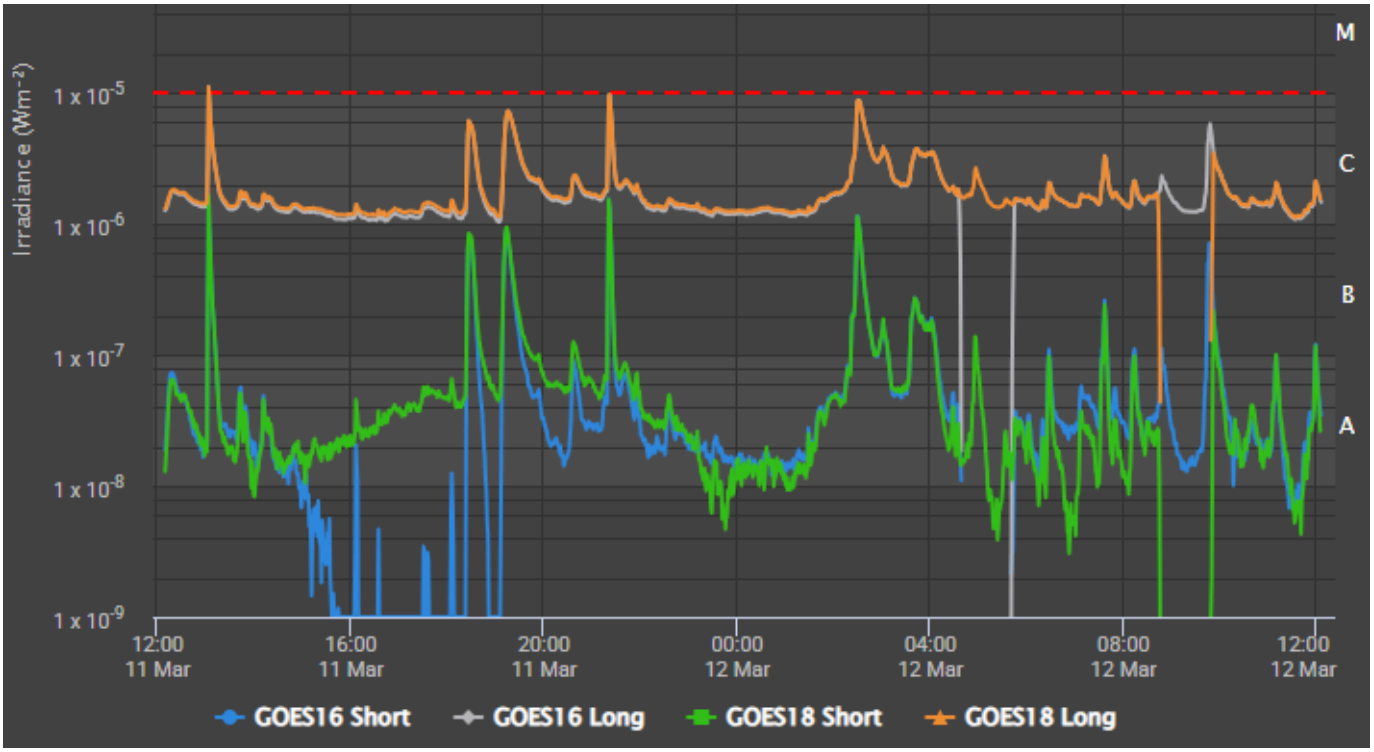
Figure 3: GOES-16 & -18 X-ray flux.



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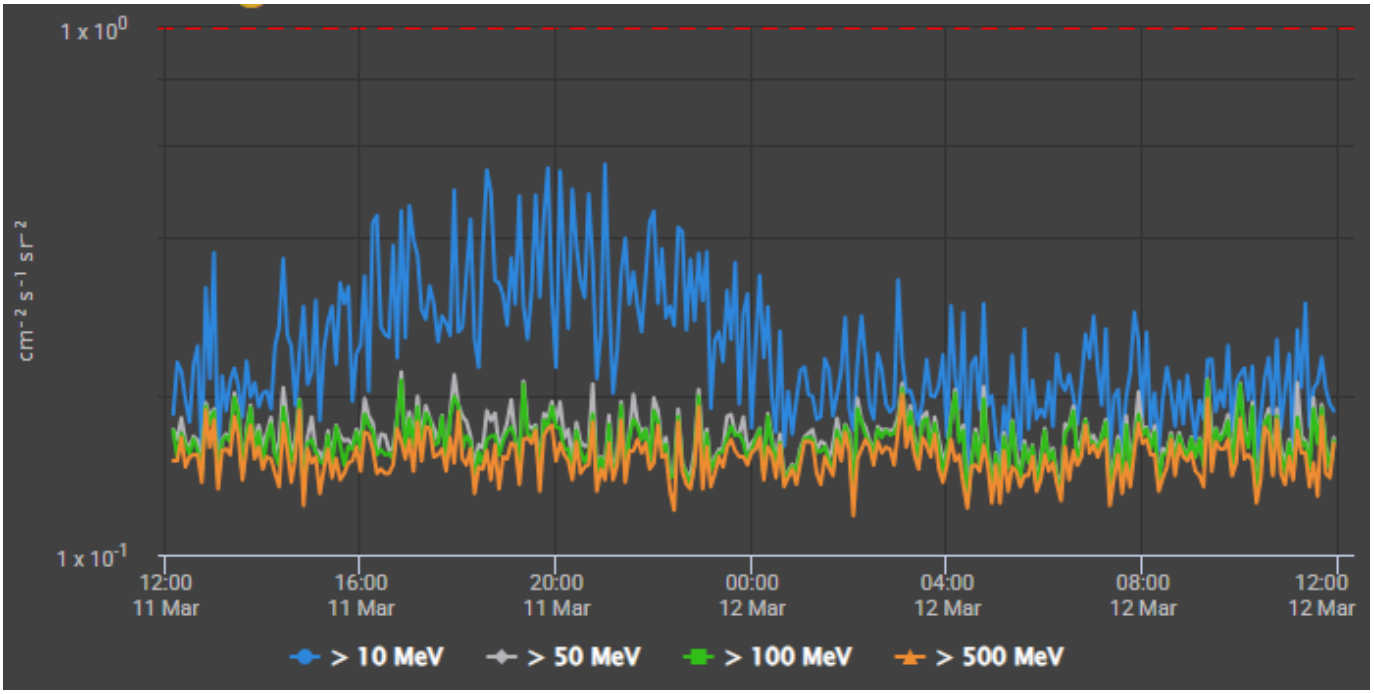
Solar Radiation Storms (High Energy Protons)

GOES18 high energy (>10MeV) proton flux rose a little above background, likely as a response to the M1.1 flare on 11 Mar, but has since fallen back to near-background levels. Background or close-to-background levels are expected to persist, with the current regions bringing a low risk of producing proton enhancements. That said, the majority of the sunspot regions are in the east of the visible disc and there is a very slightly increasing risk as these regions rotate westward into a better connected position with respect to Earth later in the period.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES-18 Proton flux.



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High Energy Electrons (≥ 2MeV)

The high-energy electron flux (>2MeV) observed at GOES16 has been reaching diurnally high levels, as solar winds continue to ease after the previous enhancement. Electron flux is expected to be diurnally high again Days 1-2 (12-13 Mar). A reduction is then likely into Days 3 and 4 (14/15 Mar) once the next coronal hole and geomagnetic activity affects GEO, likely supressing the Van Allen belts.

The 24 hour integrated fluence is currently above the Active (1e8 integrated pfu) threshold, and is expected to remain so through Day 1 and into early Day 2 (12-13 Mar). A declining trend is most probable later Day 2 and for the remainder of the period (14-15 Mar) due to coronal hole high speed stream influence. MOSWOC REFM is considered to be giving a reasonable guidance, although underplaying the maximum fluence somewhat.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	Yes	100	80	30	20
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	10	10	1	1

Figure 5: GOES-16 Electron flux.

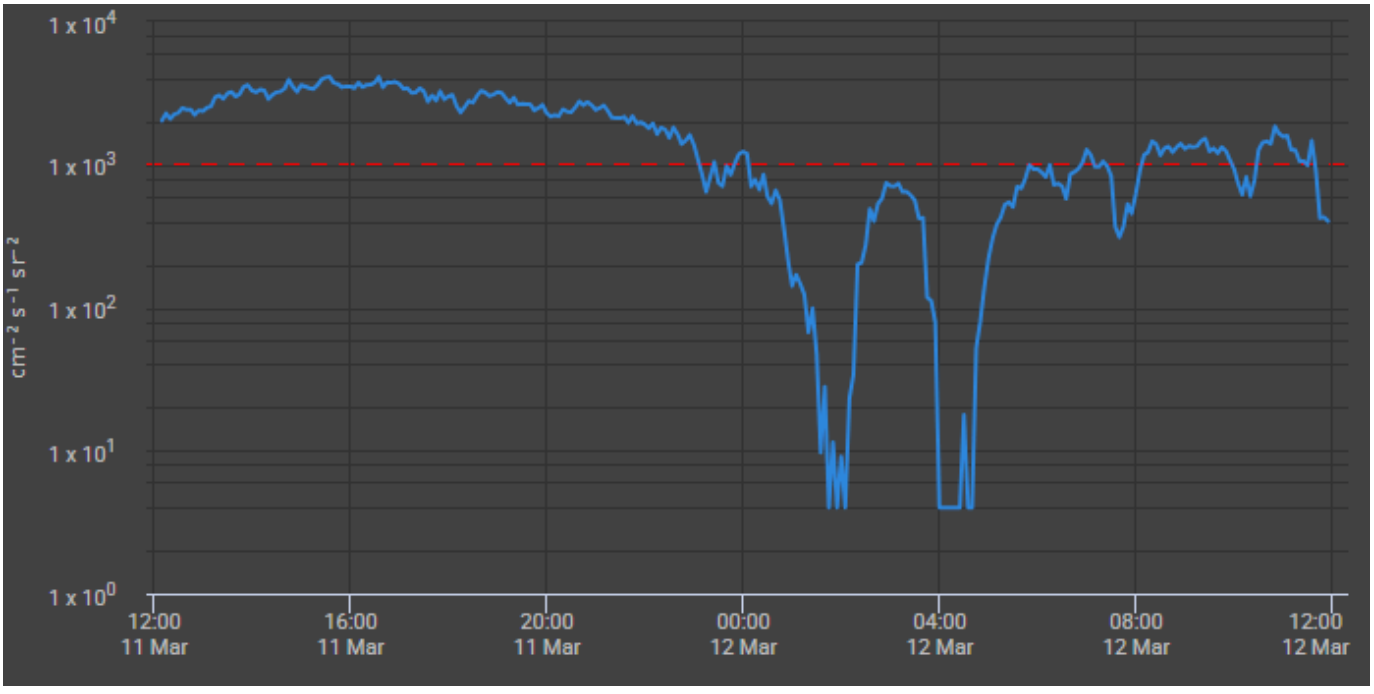

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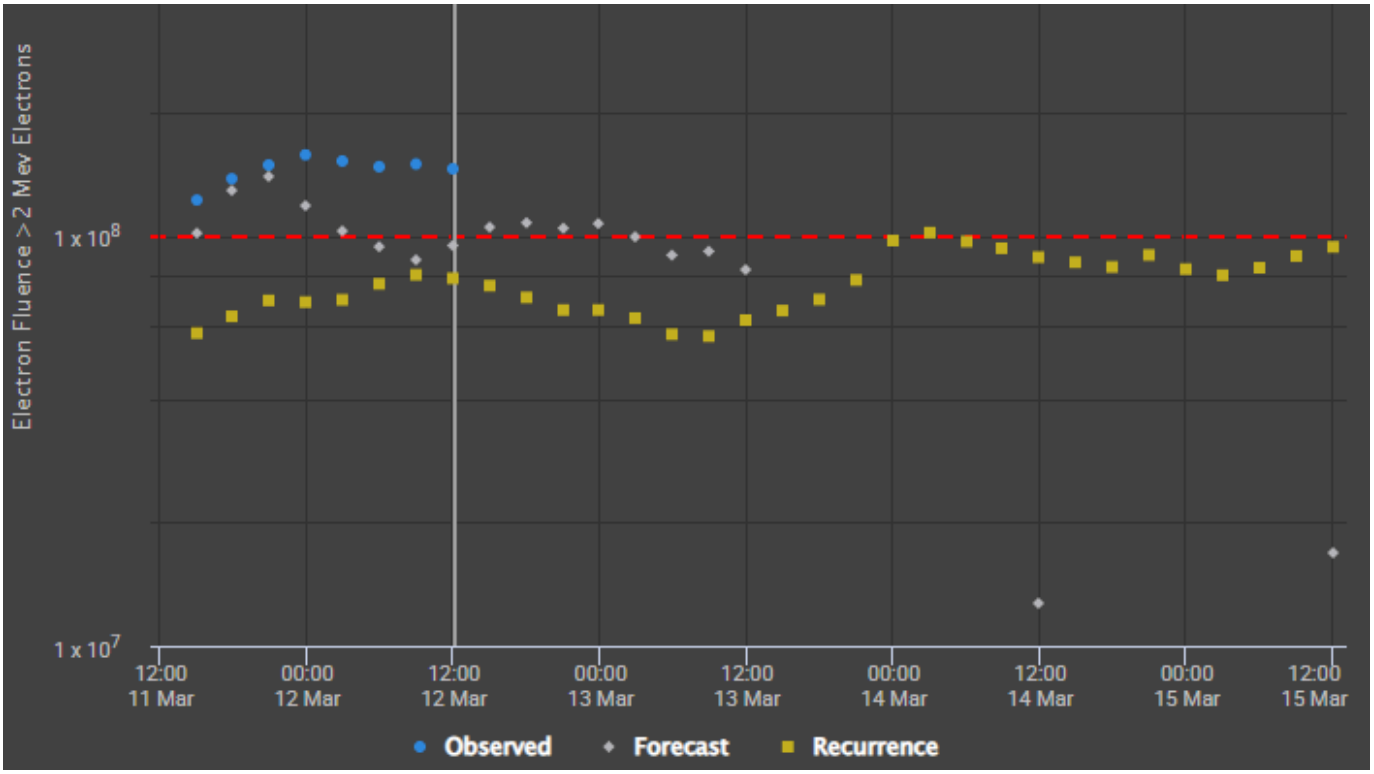
Figure 6: MOSWOC REFM.



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